DRAFT

Blueprint for Development of PM_{10} Attainment Plan for Pinal County, Arizona

prepared for:

DKS Associates
Arizona Department of Transportation

April 2006

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1. INTRODUCTION

In 1995, the Pinal County Air Quality Control District (PCAQCD) began monitoring PM_{10} concentrations in several communities across the county. At a few of these sites, occasional exceedances of the national 24-hour ambient air quality standard for PM_{10} were recorded on high wind days. These exceedances were not considered to be violations of the standard because the conditions under which these exceedances occurred qualified as exempt natural events under a Natural Event Action Plan (NEAP) developed by PCAQCD and approved the U.S. Environmental Protection Agency (EPA). At one of the sites, Eleven Mile Corner, a number of exceedances were recorded but not counted as violations because the monitor site did not comply with EPA siting guidelines.

In 2001, PM_{10} concentrations that were not exempt from consideration as violations of the national 24-hour standard began to be recorded. During this year, the monitor at the county fairground site at Eleven Mile Corner was relocated to a location on the grounds that did satisfy EPA siting criteria. In 2002, this monitor was subsequently relocated one mile north to another location that satisfied EPA criteria—the Pinal County Housing Complex, a rural residential facility. Several exceedances that could not be discounted under the NEAP were recorded in 2002 and subsequent years. In 2002, EPA declined to reapprove the NEAP submitted by PCAQCD.

In an experiment designed to monitor worse-case PM_{10} conditions in the county in 2001, PCAQCD located a special studies monitor in an area referred to as Cowtown. The monitor location is adjacent to cattle feedlots, a grain processing complex, active agricultural lands, a railroad, and a county highway. Because the monitor is surrounded by disturbed soil, it does not meet EPA siting criteria. The monitor does record frequent exceedances of the national 24-hour standard and continuous exceedances of the annual standard.

Because of the violations recorded at the Pinal County Housing Complex, PCAQCD anticipates that EPA will deem a portion of central Pinal County, where land uses include agricultural production, to be nonattainment for the PM_{10} 24-hour standard. The northernmost portion of Pinal County, including Apache Junction, is currently part of the Maricopa Area PM_{10} nonattainment of metropolitan Phoenix. A determination of whether the central portion of Pinal County violates the national annual standard cannot be made until all of the 2005 monitoring data collected at the Pinal County Housing Complex site is evaluated. Under current federal regulations, if EPA deems central Pinal County to be nonattainment for one or both of the PM_{10} standards, PCAQCD will be required to develop and submit to EPA an attainment plan. These regulations, however, have been proposed for modification, and the modifications may well make the requirements for a nonattainment plan in Pinal County moot.[1] The details of this proposal are discussed in Section 1.

This study is intended to help PCAQCD map a course for the development of a PM_{10} attainment plan, should one be required by EPA. The study includes a summary of the contents of an attainment plan, which is presented in Section 2; an analysis of the PM_{10} air quality, which is discussed in Section 3; a review of the PM_{10} emission inventory for Pinal County, which is included in Section 4; a discussion of PM_{10} air quality modeling performed in the County, in Section 5; an analysis of the process and tools available for selecting control measures to include in the plan, which is included in Section 6; an evaluation of how to prepare a PM_{10} attainment demonstration, which is presented in Section 7; and a summary of the conclusions of the study, which is contained in Section 8.

###

2. PM_{10} PLANNING REQUIREMENTS

Under Section 110(a)(1) of the federal Clean Air Act (CAA), states must submit state implementation plans (SIPs) upon request of EPA. A complete SIP must contain provisions listed in Section 110(a)(2) and must comply with requirements of 172(c). A SIP must also satisfy Part D, Subpart 4 requirements for PM_{10} nonattainment areas.

Section 110(a)(2) sets forth the general requirements of an adequate air pollution control program. Section 172(c) summarizes the general requirements for the content of an acceptable nonattainment plan. The requirements of Section 172(c) include the following:

- Implementation of all reasonably available control measures as expeditiously as practicable;
- Demonstration of attainment of national ambient air quality standards;
- Demonstration of reasonable further progress;
- Implementation of a permitting system for new or modified major stationary sources;
- Inclusion of enforceable emission limitations and control measures together with schedules for compliance by the applicable attainment date;
- Compliance with Section 110(a)(2) requirements;
- Demonstration of equivalency for the use of any modeling, emission inventory, and planning procedures not specified by EPA; and
- Implementation of contingency measures if the area fails to make reasonable further progress or attain the ambient air quality standard by the applicable date.

Part D, Subpart 4 of the CAA establishes additional timeline requirements on the attainment of PM ambient air quality standards. These timelines were originally applicable to jurisdictions that demonstrated nonattainment with PM_{10} ambient air quality standards in 1990, when the latest amendments to the CAA were adopted. For jurisdictions that are deemed nonattainment for one or both of the PM_{10} standards now, plans are typically due to EPA within three years of nonattainment designation.[2] This timing requirement, however, and the requirement for a nonattainment plan, may well be superceded by EPA action on a proposal published on January 17, 2006.

EPA is proposing to abolish the PM_{10} ambient air quality standard and substitute in its place a PM-coarse standard. The proposed standard would apply only to ambient particles with aerodynamic diameters between 2.5 and 10 microns. Furthermore, the PM-coarse standard is proposed to apply only within areas having a population of 100,000 or more where ambient PM-coarse is not dominated by emissions of windblown dust, agricultural activities, or mining operations. In metropolitan areas that are currently nonattainment for PM_{10}, such as the Maricopa area that includes the Apache Junction portion of Pinal County, the PM_{10} standard and requirements for progress toward attainment would continue in force until plans are approved by EPA for attaining the PM-coarse standard. In rural areas that are currently nonattainment for PM_{10}, such as the Hayden-Miami area that includes the northeastern corner of Pinal County, the PM_{10} standard would be revoked effective September 27, 2006.

Because the status of PM_{10} regulation is in a state of flux, EPA will probably not be designating any new PM_{10} nonattainment areas while the proposed changes in ambient air quality standards are under consideration.[3] As a result, even if the monitoring data from the Pinal County Housing Complex site demonstrate three years of exceedances of the current 24-hour PM_{10} standard, EPA will most likely not act upon these data until after September 2006. If the final rulemaking does exempt areas from regulation in which PM-coarse air quality is dominated by windblown dust, agricultural activities, or mining operations, then the need for PM attainment planning in Pinal County may be moot.

###

3. PM_{10} AIR QUALITY

PM_{10} has been monitored at a number of sites in Pinal County during 2002 through 2004, the most recent three-year period for which data are available. These monitors were located at sites intended to satisfy EPA monitoring criteria prescribed in federal regulations (40 CFR 58, Appendix D). This guidance requires state and local air quality regulatory agencies to address six basic monitoring objectives:

- To determine the highest concentrations expected to occur in the area covered by the network;
- To determine representative concentrations in areas of high population density;
- To determine the impact on ambient pollution levels of significant sources or source categories;
- To determine general background concentration levels;
- To determine the extent of regional pollution transport among populated areas and in support of secondary ambient air quality standards; and
- To determine the welfare-related impacts in more rural and remote areas (such as visibility impairment and effects on vegetation).

The design of the Pinal County PM_{10} monitoring network is intended to satisfy all of these objectives.

EPA regulations define the designations of ambient air quality monitoring stations and, for one group, the number of stations. Networks of monitoring stations operated by state and local agencies are referred to as SLAMS (State and Local Air Monitoring Station) networks. No requirements on the minimum number of SLAMS stations are prescribed. In urban areas designated as metropolitan statistical areas (MSAs), a subset of the SLAMS sites are required to be designated as National Air Monitoring Stations (NAMS). Each MSA is required to have a minimum of two NAMS stations. Since there are no MSAs located in Pinal County (the minimum population for an MSA is 50,000 in a single community and 100,000 in the metropolitan area), none of the monitoring stations are required to be designated as NAMS. EPA policy also recognizes SPMs (Special Purpose Monitors), which are established for short term monitoring purposes.

It is unclear whether the PM_{10} monitors operated by PCAQCD are SLAMS or SPMs. As the agency reports in its 2004 air quality monitoring report:

> *It appears that the EPA has not utilized the SIP process to expressly designate SLAMS monitoring sites. In some cases EPA has relied upon grant agreements under Section 105 of the Clean Air Act as the vehicle for spelling out SLAMS requirements and approving SLAMS network designs. Pinal County Air Quality does not receive Section 105 grant funding directly from the EPA, and thus Pinal County's monitors are not covered by an express agreement designating these local units as SLAMS monitors.*[4]

While PCAQCD intends that many of its PM_{10} monitors be designated as SLAMS sites, two of the monitors in its network are proposed to be designed as SPM sites. These sites are located at the City of Maricopa County Complex and at Cowtown.[3] Data recorded at these SPM sites, however, may be deemed by EPA as indicative of attainment status. In a policy memo, EPA has stated that "U.S. EPA is obligated to consider all publicly available, valid (i.e., collected in accordance with 40 CFR 58), and relevant data in the NAAQS regulatory process."[5] Thus, all of the PM_{10} monitoring data collected by PCAQCD should be considered to be eligible for use in determining nonattainment status by EPA except that which was not collected in accordance with 40 CFR 58. In the 2004 annual air quality monitoring report, PCAQCD indicates that the Cowtown site does not comply with 40 CFR 58 because the sampler is surrounded by disturbed soil.

A tabulation of the PCAQCD PM_{10} monitoring sites during 2002 through 2004 is presented in Table 1.

PM_{10} monitoring data reported by PCAQCD to EPA are stored in EPA's AQS (Air Quality Subsystem) portion of the former AIRS database. Summary data from the AQS are available online.[6] From this site, data on the estimated number of exceedances of the 24-hour PM_{10} standard at monitoring sites in Pinal County were extracted. Table 2 presents these data for 2002 through 2004.

The highest 24-Hour PM_{10} measurements recorded from 2002 through 2004 at each SLAMS and SPM station are presented in Table 3.

The AQS database reports that no exceedances of the annual PM_{10} standard occurred at the SLAMS sites during 2002 through 2004. However, the measurements collected by PCAQCD in 2003 through 2005, prior to quality control review, indicate that one of the co-located Pinal County Housing Complex monitors recorded a three-year average of 63.7 $\mu g/m^3$, which exceeds the annual PM_{10} standard of 50 $\mu g/m^3$. At the Cowtown site, the annual PM_{10} averages were 262 $\mu g/m^3$ (2002), 170 $\mu g/m^3$ (2003), and 132 $\mu g/m^3$ (2004).

Table 1 **Pinal County Air Quality Control District PM_{10} Monitoring Sites** **2002 – 2004**			
Station	2002	2003	2004
State and Local Monitoring Stations			
Apache Junction Fire Station		x	x
Apache Junction Maintenance Yard	x	x	x
Casa Grande Downtown	x	x	x
Coolidge Maintenance Yard	x	x	x
Eloy City Complex	x	x	x
Mammoth County Complex	x	x	x
Pinal Air Park	x	x	x
Pinal County Housing Complex	x	x	x
Riverside Maintenance Yard		x	x
Stanfield County Complex	x	x	x
Special Purpose Monitors			
(City of) Maricopa County Complex			x
Cowtown Road	x	x	x
Riverside Maintenance Yard	x		

Table 2 **Estimated Number of Violations of 24-Hour PM_{10} NAAAQS** **at SLAMS and SPM Stations in Pinal County**			
Station	2002	2003	2004
State and Local Monitoring Stations			
Apache Junction Fire Station	-	0	0
Apache Junction Maintenance Yard	0	0	0
Casa Grande Downtown	0	0	0
Coolidge Maintenance Yard	0	0	0
Eloy City Complex	0	0	0
Mammoth County Complex	0	0	0
Pinal Air Park	0	0	0
Pinal County Housing Complex	12	12	6
Riverside Maintenance Yard	0	0	0
Stanfield County Complex	13	6	0
Special Purpose Monitors[1]			
Cowtown	196	150	105

Notes: [1]Data for the Riverside Maintenance Yard are reported in the SLAMS section. No data are reported for the (City of) Maricopa County Complex site as that station commenced operation in December 2004.

Table 3 **Highest 24-Hour PM_{10} Concentrations** **at SLAMS and SPM Stations in Pinal County**			
Station	2002	2003	2004
State and Local Monitoring Stations			
Apache Junction Fire Station	-	103	35
Apache Junction Maintenance Yard	62	95	-
Casa Grande Downtown	69	99	52
Coolidge Maintenance Yard	106	106	35
Eloy City Complex	146	154	46
Mammoth County Complex	53	89	30
Pinal Air Park	62	108	30
Pinal County Housing Complex	166	289	155
Riverside Maintenance Yard	-	101	34
Stanfield County Complex	352	171	80
Special Purpose Monitors			
Cowtown	1,391	718	600

The data in Table 2 suggest that three monitoring sites recorded exceedances of the 24-hour PM_{10} standard in the recent past. These sites were the Pinal County Housing Complex, the Stanfield County Complex, and the Cowtown sites. Analysis of monitoring data from each of these sites is presented below.

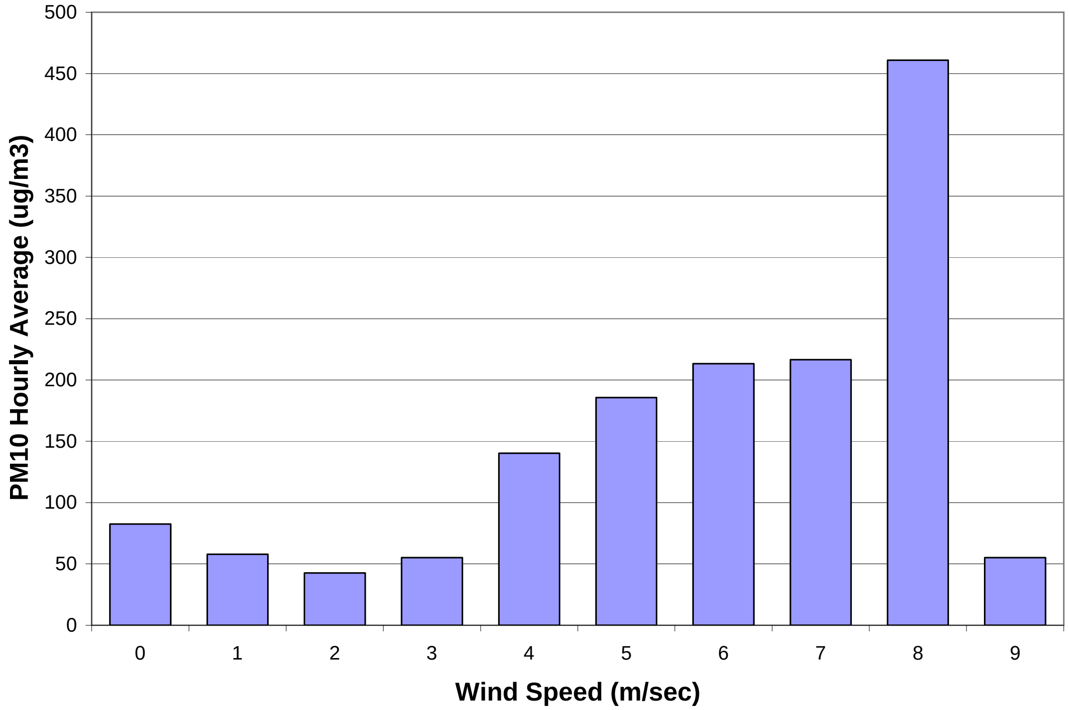
Pinal County Housing Complex

The Pinal County Housing Complex monitoring site is surrounded by sparsely vegetated desert land that is occasionally traversed by offroad vehicles or the vehicles of residents of a nearby residential housing complex. The monitor is located within a fenced area that houses the sewer lift station for the housing complex. The housing complex lies approximately 300 feet southeast of the monitor. A small dairy, two cotton gins, and the Pinal County Fairgrounds are approximately one mile to the south of the monitoring site.

PM_{10} data are currently collected at this site by both high volume filter-based samplers and a continuously recording tapered element oscillating microbalance (TEOM) monitor. Meteorological parameters are also measured by instruments mounted on a 3-meter tower. The continuously recorded data from the TEOM and the meteorological tower were evaluated to provide preliminary relationships between hourly average PM_{10} concentrations and wind speed and direction.

Figure 1 shows the relationship between PM_{10} concentration and wind speed at the Pinal County Housing Complex site in 2005. This relationship was developed by sorting

Figure 1
Average Hourly PM_{10} vs. Wind Speed
Pinal County Housing Complex, 2005



hourly averaged PM_{10} concentrations by hourly wind speed range and averaging the concentrations measured within each range. Wind speed ranges were set to span 1 meter per second (m/sec) values from 0 m/sec to 9.7 m/sec (the highest wind speed recorded).

These data suggest a strong relationship between PM_{10} concentration and wind speeds above 2 m/sec. This relationship indicates that windblown dust is a significant contributor to higher PM_{10} concentrations measured at this site. The higher average PM_{10} concentrations at the lowest wind speeds of 0 and 1 m/sec, in comparison to 2 m/sec, indicate that localized sources, such as offroad vehicle use, may be impacting the monitoring site during periods of stagnant wind condition. In an attempt to identify other relationships between PM_{10} concentrations and wind speeds, several other statistical comparisons of these data were performed. A tabulation of these PM_{10} concentration statistics in relation to wind speed ranges is presented in Table 4.

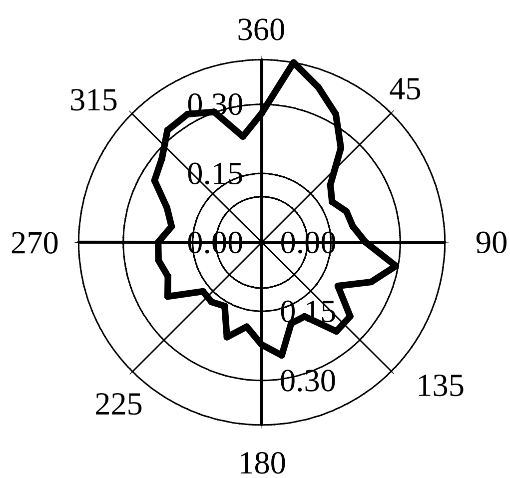
The peaking of PM_{10} maxima at 5 m/sec suggests that disturbed soil areas contributing to windblown dust impacts at the monitoring station have limited reservoirs of entrainable particles. If the soils near the monitoring station consisted of unlimited reservoirs, PM_{10} emissions would be proportional to wind speed, suggesting that soils need not be disturbed to contribute to windblown dust and that saltating particles bouncing over soil surfaces provided the driving force that released fine particles for entrainment. If the reservoirs of fine particles in surface soils are limited, then the primary force releasing

Table 4 2005 Pinal County Housing Complex PM_{10} – Wind Speed Relationships					
Wind Speed (m/sec)	PM_{10} Mean ($\mu g/m^3$)	PM_{10} Std. Dev. ($\mu g/m^3$)	PM_{10} Coef. of Variation	PM_{10} Maximum ($\mu g/m^3$)	Hour Count (# hours)
0.00 – 0.99	82.5	89.7	109%	972	2,802
1.00 – 1.99	57.8	58.9	102%	719	3,700
2.00 – 2.99	42.6	46.1	108%	938	1,248
3.00 – 3.99	55.2	148.2	269%	2,334	549
4.00 – 4.99	140.2	555.0	396%	5,903	245
5.00 – 5.99	185.7	694.6	374%	6,850	99
6.00 – 6.99	213.2	343.8	161%	1,531	39
7.00 – 7.99	216.6	195.7	90%	607	19
8.00 – 8.99	460.8	112.6	24%	619	5
9.00 – 9.99	55.1	NA	NA	55	1

fine particles most probably is anthropogenic disturbance. This result, if true, would suggest that reduction of soil disturbance by motor vehicles, or the treatment of disturbed surfaces to bind fine particles to larger ones, would reduce PM_{10} concentrations at this site.

Analyses of the relationship between PM_{10} concentrations and wind direction were also conducted. Using a conditional probability function (CPF) statistical method,[7] the probabilities of hourly PM_{10} concentrations measured when the wind blows from each of 36 compass quadrants being in the highest 30% of PM_{10} concentrations recorded during the year were plotted. A copy of this plot is presented in Figure 2. This figure indicates that PM_{10} concentrations at this monitoring site are not dominated by emissions from any single source or from sources located in any single arc upwind of the monitoring site.

Figure 2
High PM_{10} Probability by Wind Direction Sector – Pinal County Housing Complex



Stanfield County Complex

The Stanfield County Complex monitoring site is located within the small community of Stanfield, approximately 15 miles west of Casa Grande, between a county office complex and a county park. The current population of Stanfield is 650, and the primary economy is agricultural production. The monitoring site is adjacent to an unpaved access road, but otherwise there are few disturbed soil areas near the monitor. The community of Stanfield is surrounded by agricultural fields under active cultivation. PCAQCD has operated a filter-based monitor on a six-day schedule at the site since 1988, but no hourly PM_{10} data nor meteorological data have been collected at this site. As a result, no analysis of the relationship between PM_{10} concentrations and wind speed or wind direction were undertaken as a part of this study.

The peak PM_{10} concentrations appear to occur as a result of isolated events and elevated concentrations occur on schedules that vary from year to year. During 2003, for example, the median concentration of 54 24-hour readings was 35.2 µg/m^3 and the mean was 45.8 µg/m^3. Values above the mean were recorded continuously between May 9 and July 14, and elevated concentrations were recorded for a period in late October due to transported smoke from California wildfires. During 2004, the median of 60 24-hour concentrations was 31.7 µg/m^3 and the mean was 34.0 µg/m^3. During this latter year, concentrations above the mean were scattered across each month of the year except December. These results suggest that episodic sources produce peak PM_{10} concentrations at this monitor, and that some peaks are due to natural events.

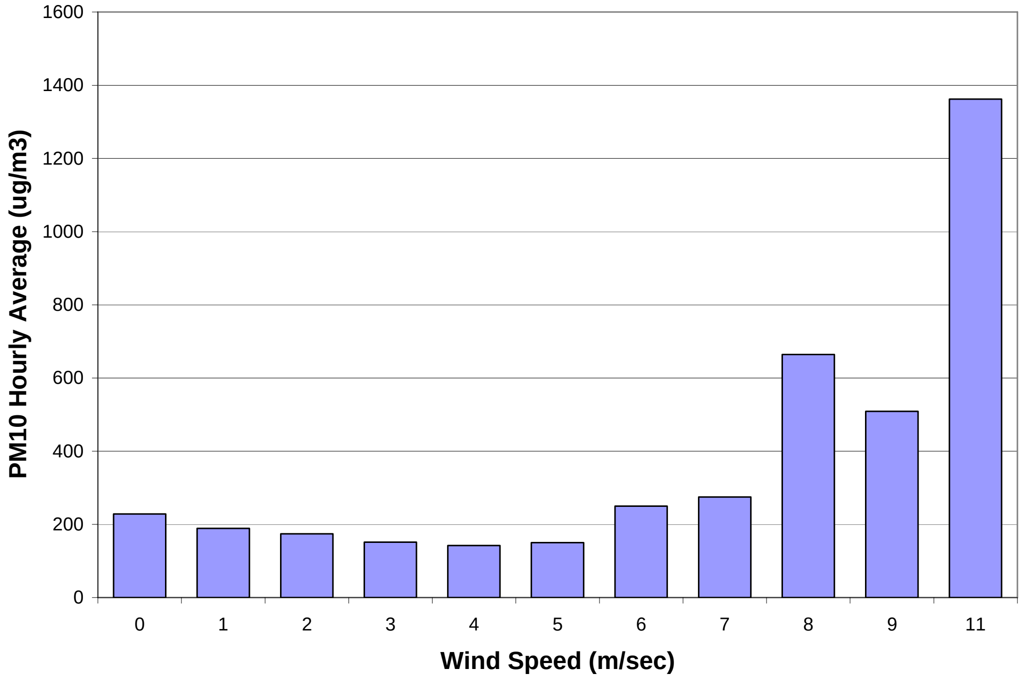
Cowtown

Cowtown is an informal name for a cattle feedlot area located approximately four miles southwest of the City of Maricopa. The monitoring site is located approximately 0.5 miles north and across a major highway and rail line from three feedlots and a grain-processing complex. Agricultural fields under active cultivation lie immediately northeast of the monitoring site.

PM_{10} data are currently collected at this site by both high volume filter-based samplers and a continuously recording tapered element oscillating microbalance (TEOM) monitor. Meteorological parameters are also measured by instruments mounted on a 3-meter tower. The continuously recorded data from the TEOM and the meteorological tower were evaluated to provide preliminary relationships between hourly average PM_{10} concentrations and wind speed and direction.

Figure 3 shows the relationship between PM_{10} concentration and wind speed at the Cowtown site in 2005. This relationship was developed by sorting hourly averaged PM_{10} concentrations by wind speed range and averaging the concentrations measured within each range. Wind speed ranges were set to span 1 meter per second (m/sec) values from 0 m/sec to 11.5 m/sec (the highest wind speed recorded).

Figure 3
Average Hourly PM_{10} vs. Wind Speed
Cowtown, 2005



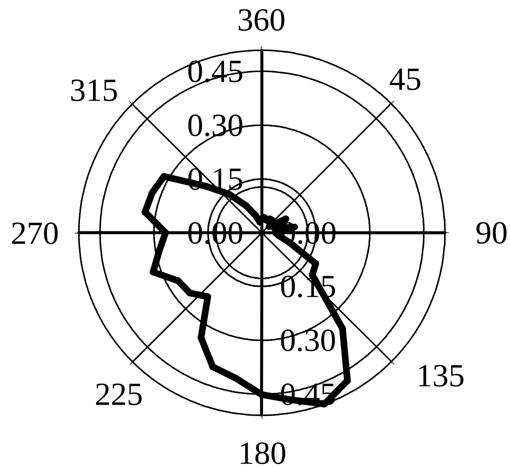
These data suggest a rather uniform relationship between PM_{10} concentration and wind speeds up to 8 m/sec. This relationship suggests that windblown dust is not a significant contributor to higher PM_{10} concentrations measured at this site except at the highest 1% of wind speeds measured. To better understand these relationships, several other statistical comparisons of these data were performed. A tabulation of these PM_{10} concentration statistics in relation to wind speed ranges is presented in Table 5.

The highest maximum concentrations occurring at very low wind speeds suggest that PM_{10} concentrations at the Cowtown site are dominated by nearby emission sources whose impacts are the highest when winds during relatively stagnant conditions blow from these sources to the monitor. Elevated coefficients of variation reported at low wind speeds also suggest that the dominating sources are confined within discrete ranges of wind direction and not scattered around the compass, as is suggested by the distributions at the Pinal County Housing Complex site.

Analyses of the relationship between PM_{10} concentrations and wind direction were also conducted. Using a conditional probability function (CPF) statistical method, the probabilities of hourly PM_{10} concentrations measured when the wind blows from each of 36 compass quadrants being in the highest 30% of PM_{10} concentrations recorded during the year were plotted. A copy of this plot is presented in Figure 4. This figure indicates that sources to the south and southwest of the Cowtown monitoring site, where the feedlots and grain mill operation are located, significantly impact PM_{10} concentrations at the monitor.

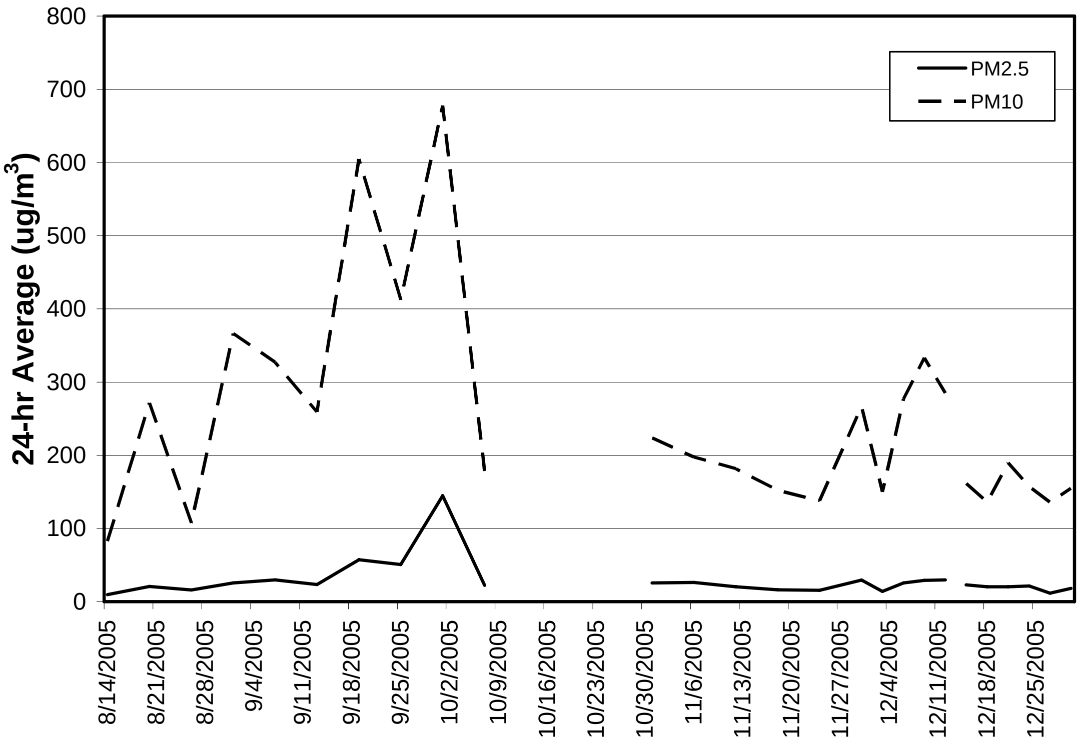
Table 5 2005 Cowtown PM_{10} – Wind Speed Relationships					
Wind Speed (m/sec)	PM_{10} Mean ($\mu g/m^3$)	PM_{10} Std. Dev. ($\mu g/m^3$)	PM_{10} Coef. of Variation	PM_{10} Maximum ($\mu g/m^3$)	Hour Count (# hours)
0.00 – 0.99	228	467	2.05	6445	939
1.00 – 1.99	189	357	1.89	4675	3825
2.00 – 2.99	174	294	1.68	3170	2315
3.00 – 3.99	151	229	1.52	1970	866
4.00 – 4.99	142	230	1.63	1987	422
5.00 – 5.99	150	163	1.08	861	183
6.00 – 6.99	250	369	1.48	1817	119
7.00 – 7.99	275	612	2.22	3876	45
8.00 – 8.99	664	1093	1.65	4628	19
9.00 – 9.99	509	395	0.78	988	6
11.00 – 11.00	1362	NA	NA	1362	1

Figure 4
High PM_{10} Probability by Wind Direction Sector – Cowtown



In July 2005, PCAQCD commenced monitoring $PM_{2.5}$ at the Cowtown site. This monitoring was performed using a filter-based FMR sampler operating every sixth day. The comparison of these data to PM_{10} measurements show an r^2 correlation of 0.85. A plot of these data are shown in Figure 5.

Figure 5
Cowtown $PM_{2.5}$ vs. PM_{10}



To determine whether Cowtown $PM_{2.5}$ concentrations correlated better with those monitored at other sites in the county, we compared $PM_{2.5}$ data from the Cowtown, Casa Grande, and Apache Junction monitoring sites. These comparisons, for the period of July through December 2005, showed r^2 correlation coefficients of 0.20 for Cowtown-to-Apache Junction $PM_{2.5}$ and –0.03 for Cowtown-to-Casa Grande $PM_{2.5}$. These analyses indicate that $PM_{2.5}$ concentrations at the Cowtown site are influenced significantly by local source emissions that do not transport to areas to the east such as Casa Grande or to the northeast at Apache Junction. This analysis also indicates that $PM_{2.5}$ is not a significant contributor to PM_{10} concentrations measured at the Cowtown monitoring site.

###

4. PM_{10} EMISSION INVENTORY

A 2002 emission inventory for Pinal County has been prepared by the Western Regional Air Partnership (WRAP).[8] For this analysis, only primary PM_{10} data were extracted from the WRAP inventory. Primary PM_{10} is defined for this inventory in the manner that the term is used in EPA's National Emission Inventory for 2002 as the combination of filterable and condensable particulate matter smaller than 10 microns. Although the inventory also contains data on filterable PM_{10} emissions, this parameter is not fully reported for all source categories. For several facility point source entries, for example, only primary PM_{10} is listed in the WRAP inventory. Primary PM_{10} emission inventory data were also evaluated in this section as this is the pollutant form to which EPA attaches more weight in the development of PM_{10} nonattainment plans, even though the continuous TEOM monitors from which data were analyzed in the previous sections record concentrations of essentially filterable PM_{10}. The WRAP 2002 emission inventory for Pinal County reports filterable PM_{10} to constitute 95.2% of primary PM_{10}.

Primary PM_{10} emissions are tabulated for major inventory categories and several significant subcategories in Table 6.

Table 6
Pinal County 2002 Primary PM_{10} Emission Inventory

Emission Category	Primary PM_{10} Emissions	
	(tons/yr)	% of Total*
Point Sources		
Metal Mining	1,265	6.21%
Manufacturing	117	0.57%
Electrical Utility	172	0.84%
Municipal Landfill	15	0.07%
Other	49	0.24%
Subtotal	1,618	7.94%
Area Sources		
Fuel Combustion	89	0.44%
Paved Road Use	769	3.77%
Unpaved Road Use	4,073	20.0%
Non-Road Construction	768	3.77%
Road Construction	4,714	23.1%
Mining & Quarrying	761	3.73%

Table 6 **Pinal County 2002 Primary PM_{10} Emission Inventory**		
Emission Category	Primary PM_{10} Emissions	
	(tons/yr)	% of Total*
Open Burning	906	4.45%
Agricultural Tilling	5,008	24.6%
Cotton Ginning	124	0.61%
Other	233	1.14%
Subtotal	17,445	85.6%
Wildfires	868	4.26%
On-Road Mobile	242	1.19%
Nonroad Mobile	208	1.02%
Grand Total	20,381	100%

*Totals may not add due to rounding.

The primary PM_{10} emission inventory is dominated by fugitive dust sources included in the area source grouping. This outcome corresponds with the PM_{10} monitoring data that demonstrate the significant variability in annual average and maximum 24-hour concentrations between reporting stations. If emissions of fine PM_{10} (i.e., $PM_{2.5}$) from combustion sources dominated the emission inventory, PM_{10} concentrations would be more uniform across the county. PM_{10} emitted by fugitive dust sources tends to impact ambient concentrations primarily within a few miles of emission sources.

Recently, PCAQCD began using a new emission inventory software package recommended by the Arizona Department of Environmental Quality. This package, developed by Lakes Environmental Software (Lakes Environmental), provides a GIS-based platform for spatially locating emissions from stationary, area, and mobile sources. Data on episodic sources such as open burning and windblown dust can also be maintained in the software. While the software does include several EPA emissions estimation models, which can be used to compute emissions from limited source types, it does not possess the capability of computing PM_{10} emission rates from fugitive dust sources. These emissions rates must be manually entered by the user or imported from other databases.

Emission inventory platforms like that developed by Lakes Environmental provide a tool for cataloging emission sources by many different parameters, including location. Because of its geographical positioning system (GPS) capabilities, fugitive dust sources such as active agricultural parcels, can be spatially identified in the inventory, and the set of such sources near a monitoring site, or a sensitive receptor, can be extracted from the inventory. With modification, emission equations for windblown dust (in the case of disturbed soils) or motor vehicle travel PM_{10} emissions (in the case of unpaved road use) can be stored in the inventory and used to compute emissions with the entry of appropriate activity data. Such activity data for agricultural parcels would include the roughness height of the disturbed soil surface and the silt content of the soil. Because silt content varies across the central agricultural region, and because surface roughness may vary on an individual field by season, collection and entry of these data countywide would require significant staff resources. Some utility does exist, however, for maintaining this level of source detail for parcels in microinventory areas surrounding monitoring sites recording violations of the 24-hour standard. While useful for region-wide analysis—which is more appropriate for $PM_{2.5}$—an alternative use of this software would be to focus on representing microinventory areas adjacent to monitoring sites.

###

5. PM_{10} AIR QUALITY MODELING

Very limited air quality modeling of PM_{10} emissions has been conducted in Pinal County. In the absence of any need to evaluate source-receptor relationships as part of an air quality planning effort, the modeling of PM_{10} ambient air quality has not been a priority of PCAQCD or any other air quality regulatory agency. The limited modeling that has been done either supports stationary source permitting or initial source-receptor investigations.

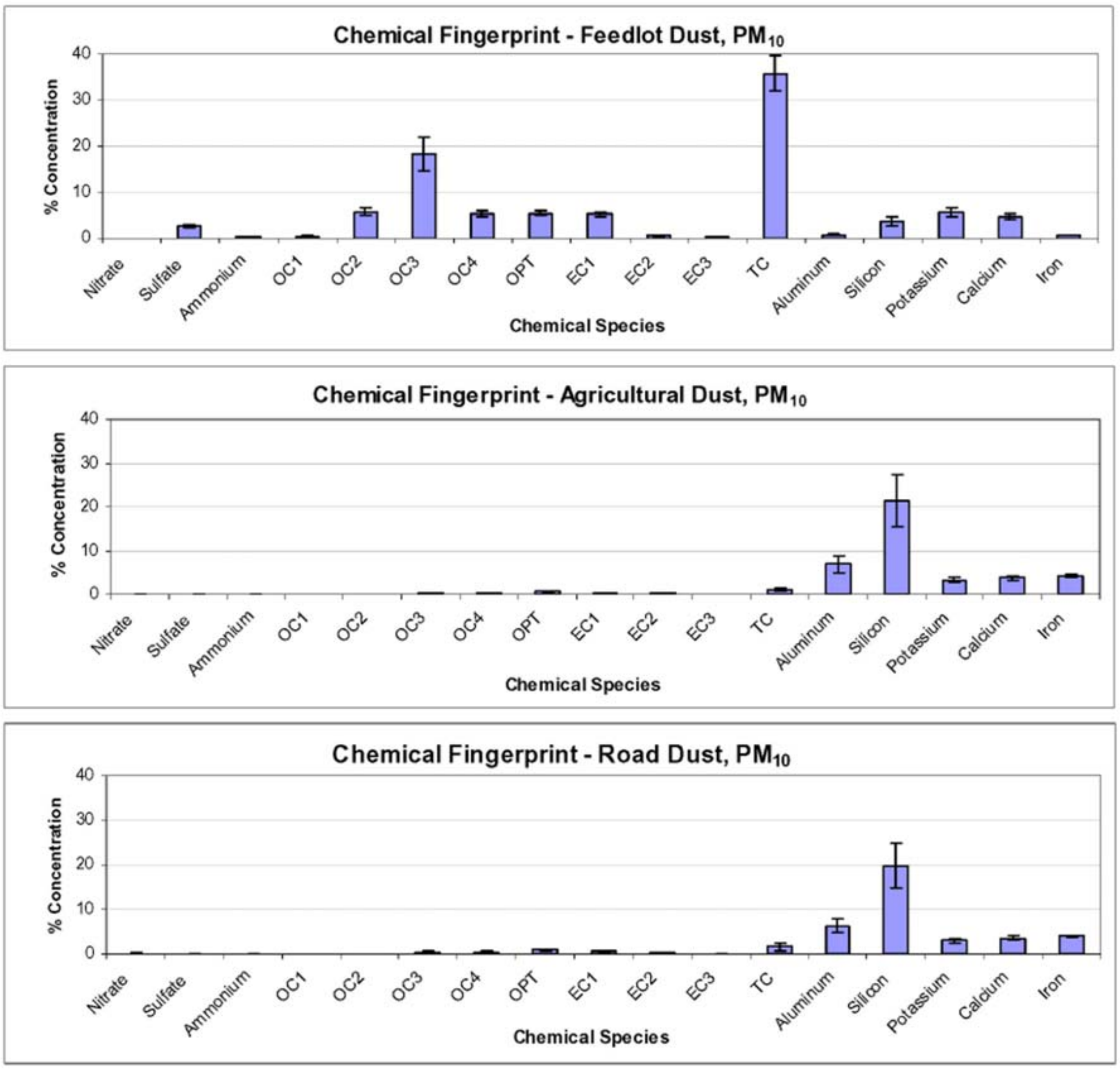
Proposed major stationary sources, or major modifications of existing stationary sources (i.e., facilities or modifications having the potential to emit 100 tons per year or more of any criteria pollutant), are required to be evaluated for downwind ambient air quality impacts using EPA-approved dispersion modeling. For sources of PM_{10}, the increases in downwind concentrations are not allowed to exceed 17 $\mu g/m^3$ - annual average or 30 $\mu g/m^3$ - 24-hr average. All of the major stationary sources and major modifications approved by PCAQCD have demonstrated compliance with these downwind requirements through dispersion modeling.

The second PM_{10} air quality modeling effort undertaken in Pinal County in the past few years was the analysis of PM_{10} source-receptor relationships at five PM_{10} monitoring sites using chemical mass balance (CMB) methods.[9] Ambient PM_{10} and $PM_{2.5}$ samples were collected at Casa Grande, Coolidge, Cowtown, Pinal County Housing, and Stanfield in October and November of 2003. Soil samples were collected from feedlots, agricultural lands, and unpaved roads near the Cowtown monitoring site.

Ambient PM_{10} was collected at the monitoring sites on Teflon and quartz fiber filters. The Teflon filter were analyzed by X-ray fluorescence spectrometry for 40 elemental species and weighed for mass. The quartz filters were analyzed for the cations Na^+ and K^+ by atomic absorption, for ammonium (NH_4^+) by automated colorimetry, and for the anions SO_4^{2-}, NO_3^-, and Cl^- by ion chromatography, and the eight species of elemental and organic carbon by thermal/optical reflectance carbon analysis. The soil samples were resuspended onto Teflon and quartz fiber filters and analyzed in the same manner as the ambient filters to produce compositional fingerprints of these soils.

The results of these analyses were used by Desert Research Institute (DRI) to perform a CMB analysis allocating ambient PM_{10} concentrations to fingerprinted sources. Because other sources not unique to Pinal County also contribute to local air quality there, the fingerprints of PM_{10} emissions from other sources, such as motor vehicle exhaust, vegetative burning, and coal power plants, were selected by DRI from archives of source signatures for use in the analysis. The constituent analysis of local soils indicated that agricultural dust at the Cowtown site was compositionally almost identical to unpaved road dust in the same vicinity and, thus, very difficult to differentiate in the ambient samples. The feedlot dust was found to have much greater organic and total carbon contents, and much less silicon, than the agricultural and unpaved road dusts. Figure 6 compares the primary constituents in these three soil samples.

Figure 6
PM_{10} Surface Material Chemical Fingerprints



The CMB analysis indicated that soil-based emissions were the greatest contributor to PM_{10} measured at the five monitoring sites. Geological soil provided the highest contributions at four of the monitoring sites, and feedlot soil produced the highest impacts at the Cowtown site. At sites other than Cowtown, feedlot soil produced the second highest impacts, even though feedlots and dairies were located several miles from the monitoring sites. PCAQCD staff hypothesized that the use of cow manure as a fertilizer on nearby agricultural fields may have enhanced the feedlot soil signature at these sites.

A study of cattle feedlot downwind ambient PM composition was conducted in the San Joaquin Valley in September 1972.[10] This study reports similar ratios of calcium and potassium to silicon in ambient PM downwind and close to feedlot corrals that are repeated in the resuspended dust from feedlot soil at Cowtown. The San Joaquin Valley study, however, reports that PM emissions from a feedlot decrease rapidly and are almost undetectable at a distance of 750 meters downwind of the feedlot boundary.

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6. CONTROL MEASURE SELECTION

The Clean Air Act requires that nonattainment plans assure the implementation of all reasonably available control measures as expeditiously as practicable. In serious area PM_{10} nonattainment areas, plans must assure the implementation of Best Available Control Measures (BACM). BACM is defined as:

> *…the maximum degree of emissions reduction of PM_{10} and PM_{10} precursors from a source …which is determined on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, to be achievable for such source through the application of production processes and available methods, systems, and techniques for control of each pollutant.*[11]

BACM is to be applied to each significant emission source category. A significant emission source category is one that produces PM_{10} impacts that are greater than 1 $\mu g/m^3$ – annual average, or 5 $\mu g/m^3$ – 24-hour average, at an approved monitoring site recording exceedances of national ambient air quality standards. Any source category that produces PM_{10} impacts below these thresholds is considered to be de mimimis and exempt from the application of BACM controls.

The feasibility of any BACM candidate control measure is evaluated in a two-step process. In the first step, a measure is evaluated for technological feasibility. Measures are typically disqualified on technological grounds if resources with limited availability—such as water—would be consumed, if adverse environmental impacts would occur, or if significant energy demands would result. A candidate measure may also be infeasible if it violates a statute or regulation.

The second step in the feasibility analysis is the test of economic feasibility. Economic feasibility is determined through the calculation of a measure's cost-effectiveness and the comparison of this value to a cost-effectiveness ceiling adopted as agency policy. For example, the San Joaquin Valley Unified Air Pollution Control District has adopted a cost-effectiveness ceiling of $5,700 per annual ton of PM_{10} reduced as a determinant in the analysis of control equipment in Best Available Control Technology decisions and in the analysis of control measures for BACM decisions.[12] The cost-effectiveness value for a control measure is the ratio of annualized control measure cost to the annual emission reductions achieved by the application of the control measure to a particular area source. The general methodology of calculating a cost-effectiveness ratio is presented in the WRAP Fugitive Dust Handbook.[13] Emission reductions can be calculated through a series of alternate emission factors and emission factors equations. Control measure costs likewise can be calculated using regional default data or locally collected cost data. Sources of cost data include BACM studies conducted for other serious PM_{10} nonattainment areas[14] and cost analyses prepared by private and public agencies.

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7. PM_{10} ATTAINMENT DEMONSTRATION

The critical analysis required in any attainment plan is the demonstration of attainment with ambient air quality standards. For compliance with PM_{10} standards, this analysis typically includes an assessment of the relationships between source emissions and air quality at the violating PM_{10} monitors and a plan for reducing emissions from these sources by a sufficient degree to reduce cumulative PM_{10} impacts at these monitors to air quality standard levels.

A number of analytical approaches are available to quantify the relationships between source emissions and impacts. These include the use of computation methods to quantify emissions from individual sources and compute impacts at discrete downwind monitoring locations (dispersions modeling) and, conversely, to evaluate the composition of collected particulate and relate this composition to source emission profiles (receptor modeling). Other approaches use meteorological data to map trajectories backwards in time to identify contributing sources, and saturation monitoring to spatially map the gradient of PM_{10} concentrations between suspected contributing sources and affected monitoring sites. The selection of an analytical approach should be based on the data resources available.

EPA guidance requires that the most accurate analytical methods for which input data are available be used to identify the significance of source emission impacts at monitoring sites where violations of air quality standards are expected.[15] EPA, in ranking analytical methods, recommends "…(1) use of receptor and dispersion models in combination (preferred); (2) use of dispersion models alone; and (3) use of two receptor models, with control strategy developed using a proportional model."[16]

The modeling methods employed by other serious PM_{10} nonattainment areas are instructive of approaches that have been accepted by EPA. The serious PM_{10} nonattainment areas evaluated in this study include Maricopa County, Arizona; Clark County, Nevada; and San Joaquin Valley, California. In each of these areas, fugitive dust emissions contribute significantly to violations of the PM_{10} standards.

The PM_{10} nonattainment plan for Maricopa County, Arizona, was approved by EPA on January 14, 2002. The Maricopa County plan used a gridded photochemical dispersion model approach to demonstrate attainment of the PM_{10} annual standard and a microscale dispersion modeling approach to demonstrate attainment of the 24-hour standard.[17] A portion of annual PM_{10} is produced by the conversion of gaseous pollutant emissions into particles, and the use of a photochemical model was useful in forecasting emission trends for this component as future gaseous emission control measures were implemented.

Because this methodology is resource intensive with respect to data collection and analysis, and because aerosols do not contribute to Pinal County PM_{10} air quality to the same extent, this methodology is not recommended for use by PCAQCD.

To determine compliance with the 24-hour PM_{10} standard, the Maricopa Association of Governments submitted to EPA a microscale analysis of fugitive dust source emissions developed by the Arizona Department of Environmental Quality.[18] This analysis uses different dimensions for the microscale modeling domains at different monitoring sites. The domains were chosen after screening dispersion modeling analysis to include all fugitive dust sources that would have significant impacts (e.g., greater than 5 µg/m^3 – 24-hour average impacts) at each applicable monitoring site. The domains varied from an approximate 0.17 mile radius to a 3.0 mile radius. Windblown dust from disturbed soil areas was a significant source because the 24-hour design day was a high wind day at each of the monitoring sites. The concept of using pre-screening to differentiate significant from less-than-significant sources was approved by EPA and is a good tool for use by PCAQCD in selecting microscale domain dimensions.

The Clark County, Nevada PM_{10} nonattainment plan was approved by EPA on May 3, 2004. The nonattainment plan used an emission inventory rollback method to demonstrate attainment of the annual and 24-hour PM_{10} standards. Only one monitoring site, at the J.D. Smith School, recorded an exceedance of the annual standard during the baseline period. This site and five others reported exceedances of the 24-hour standard. Clark County Department of Comprehensive Planning (CCDCP) concluded from analysis of monitoring data that PM_{10} impacts at violating monitoring sites were driven by sources located within 2 kilometers of each monitoring site. CCDCP assumed the non-background portion of measured PM_{10} was proportional to the individual emission contributions of sources with the 2-kilometer microinventory area. Background was assumed to be equal to the lowest PM_{10} measurement recorded at any monitoring site on the design day or year plus an annual average aerosol contribution of 3.5 µg/m^3 as determined by Desert Research Institute through chemical mass balance modeling. The emissions reductions estimated for application of candidate control measures, as a fraction of the total emission inventory of each microinventory area, were applied to the design day and year PM_{10} concentrations to demonstrate attainment. EPA Region IX approved this approach in recognition of the difficulty in parsing fugitive dust source contributions using receptor models and the corresponding uncertainty in emission factors and activity levels used in dispersion modeling. This approval suggests that use of a microinventory rollback approach may be the most cost-effective method of determining necessary emission reductions and demonstrating future attainment in Pinal County.

The San Joaquin Valley PM_{10} nonattainment plan was approved by EPA on April 28, 2004. The plan's air quality data indicate that exceedances of the 24-hour PM_{10} standard were determined to occur in fall and winter months in this region during periods of low wind velocity.[19] These exceedances were dominated by secondary aerosol formed through the interaction of NOx from combustion sources and ammonia emitted by agricultural operations. Chemical mass balance data were used to quantify the contribution of primary and secondary particulate sources at each monitoring site recording exceedances, and the attainment demonstration was performed using a modified rollback method.

Because EPA guidance requires the use of two receptor models if dispersion modeling is not used, the San Joaquin Valley Unified Air Pollution Control District used a correlation coefficient approach to verify CMB analyses. For this planning effort, a Classification and Regression Tree (CART) model was used to correlate PM_{10} and $PM_{2.5}$ concentrations with meteorological conditions.[20] At each of the three monitoring sites studied, atmospheric stability correlated best with high PM_{10} concentrations, and visibility correlated best with high $PM_{2.5}$ concentrations. Not surprisingly, high $PM_{2.5}$ also correlated well with nighttime low temperatures conducive to the formation of ammonium nitrate.

Because the San Joaquin Valley 24-hour PM_{10} exceedances occur during the fall and winter when secondary aerosol is the primary constituent, the attainment demonstration modeling approach will be of little use in evaluating peak PM_{10} source-receptor relationships.

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8. CONCLUSIONS

An acceptable PM_{10} nonattainment plan must contain all of the elements prescribed by the federal Clean Air Act. These elements primarily include an emission inventory, the implementation of Best Available Control Measures, and a demonstration of attainment.

The emission inventory prepared by PCAQCD and WRAP for Pinal County satisfies minimum CAA emission inventory requirements. The emission inventory platform developed for use in Arizona by Lakes Environmental will extend the capabilities for emission analysis, but will not readily facilitate compliance with CAA attainment demonstration requirements.

The choice of BACM will be dependent on the conclusions made by PCAQCD on the cost-effectiveness of each candidate measure. Estimates of control measure effectiveness and cost can vary significantly depending on the research data used in computing cost-effectiveness. The choice of a cost-effectiveness ceiling is also a policy choice to be made by PCAQCD with EPA's concurrence.

The demonstration of attainment will require additional studies and analysis. Impacts at each of the Cowtown, Pinal County Housing, and Stanfield monitoring sites, if continuing to demonstrate nonattainment in 2005, should be evaluated first by construction of microinventories of significant sources. This work should be performed through the mapping of potentially significant sources within a 300-meter radius (an impact zone found to contain most significant sources in microscale inventory modeling in the MAG and San Joaquin Valley regions), the determination of maximum activity rates or disturbance levels, and the modeling of emissions from these sources on high concentration days. The results of such modeling can be used to determine whether the microinventory radius should be increased to capture other significant sources (i.e., those with the potential to produce impacts at the monitor in excess of 5.0 $\mu g/m^3$ – 24-hour average) or whether the initial microinventory area is sufficient.

When site investigations cannot locate potentially significant sources, other means of source-receptor analysis may be required. Two methods discussed earlier have the potential to identify the wind directions or the meteorological conditions under which elevated concentrations occur. The first is the use of the CPF statistical method to identify the upwind directions in which significant sources are located. The second is the use of the CART statistical method to determine the set of meteorological conditions under which elevated concentrations are more probable. A third approach would be to install a video camera at the monitoring site that was activated during periods of high

PM_{10} concentrations to record images of the area surrounding the monitor or of the area upwind of the monitor.

The use of chemical speciation methods to identify significant sources has very limited value in the central Pinal County area. The emission inventory and the limited CMB study conducted in this area indicate that fugitive dust sources dominate local PM_{10} concentrations. CMB cannot be used directly to distinguish the separate contributions of such sources because of the strong similarities in elemental signatures of dust emissions.

Spatially distributed monitoring, however, can be used to map the gradient of PM_{10} concentrations in an area affected by several fugitive dust sources. Such monitoring, referred to as saturation monitoring, is conducted using self-contained PM_{10} samplers such as MiniVols.[21] EPA retains an inventory of MiniVols for loan to state and local air quality regulatory agencies for saturation studies.[22] Such samplers, when deployed in a network surrounding a monitoring site for simultaneous single day monitoring, can add information about the local PM_{10} gradient that cannot be fully elucidated from the analysis of hourly PM_{10} and meteorological data recorded at the monitoring site.

Once the impacts of significant sources in the microinventory areas have been quantified, then appropriate control measures can be developed to demonstrate attainment. The pool of research data on the effectiveness of alternative fugitive dust control measures continues to expand every year. Bibliographies of these research studies are also published periodically in compendiums such as the WRAP Fugitive Dust Handbook[23] and other documents.[24]

Finally, the development of a PM_{10} attainment plan should borrow heavily on EPA's actions on plans developed by other serious nonattainment areas. The Technical Support Documents prepared by EPA staff in review of these plans identify the logic by which EPA approves or rejects components of submitted plans. These TSDs constitute a trove of policy and technical information that will help guide the preparation of any plan prepared for Pinal County.

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